

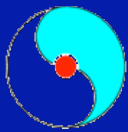
# **PHENIX Run-6 and Perspectives**

*Run Coordinator's Point of View*



**Abhay Deshpande**  
**Stony Brook & RBRC**

**RHIC Retreat, Port Jefferson**  
**July 10, 2006**



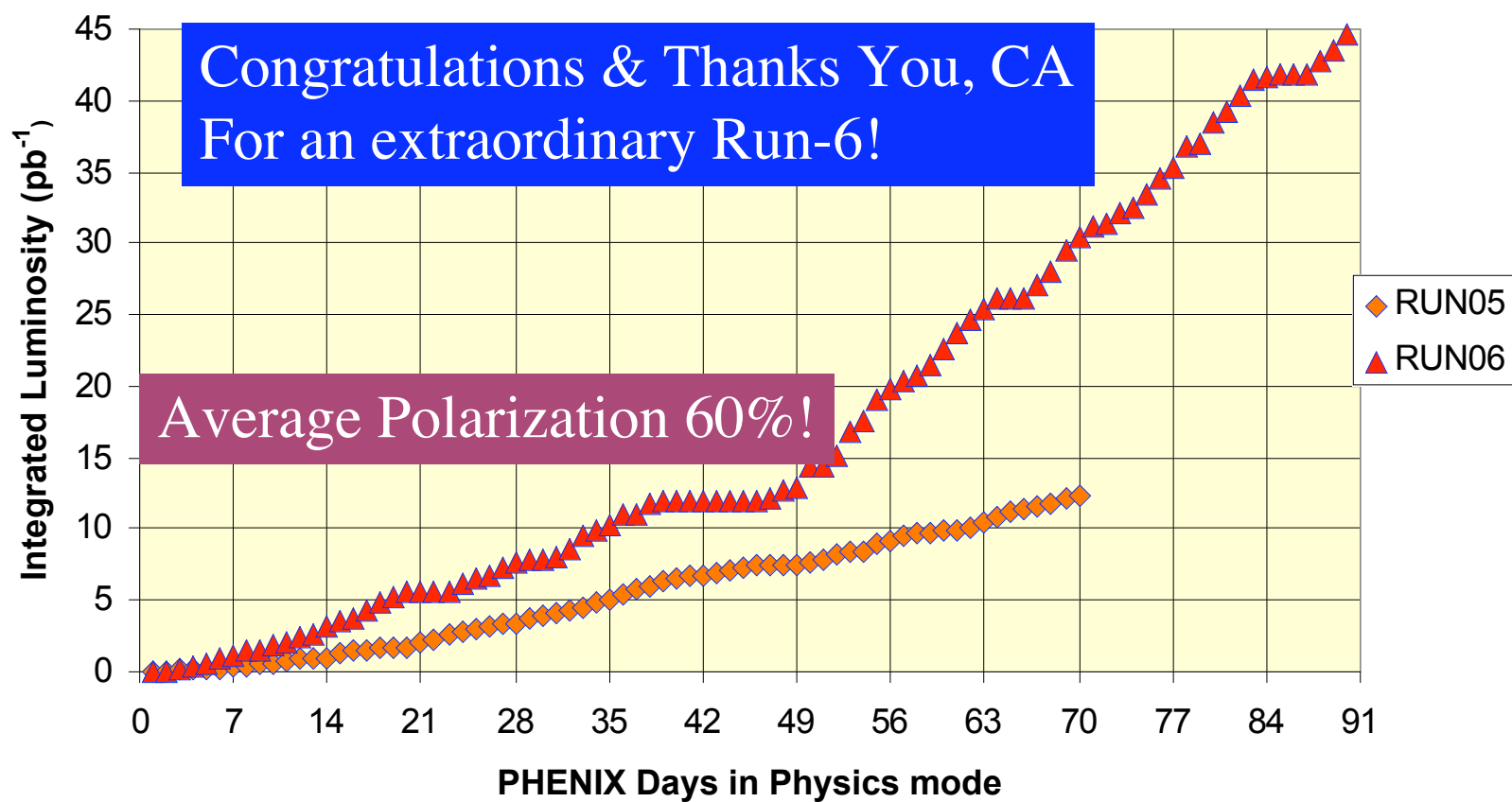
# A walk through this talk

- PHENIX Run-6 planning and aspirations
- Run-6 Reality
  - PHENIX Operation and Run-6 data summaries
  - Data handling, analysis plans & expected results
- Comments on operations
- Run-7

# RHIC Luminosity Run-6 vs. Run-5

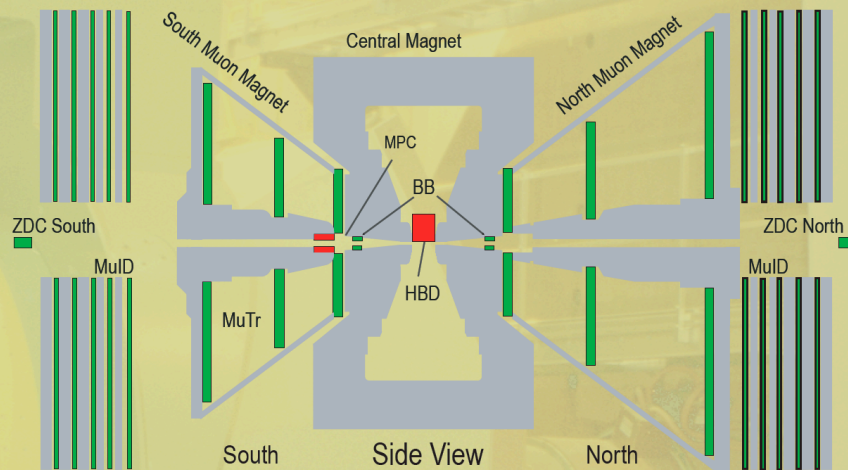
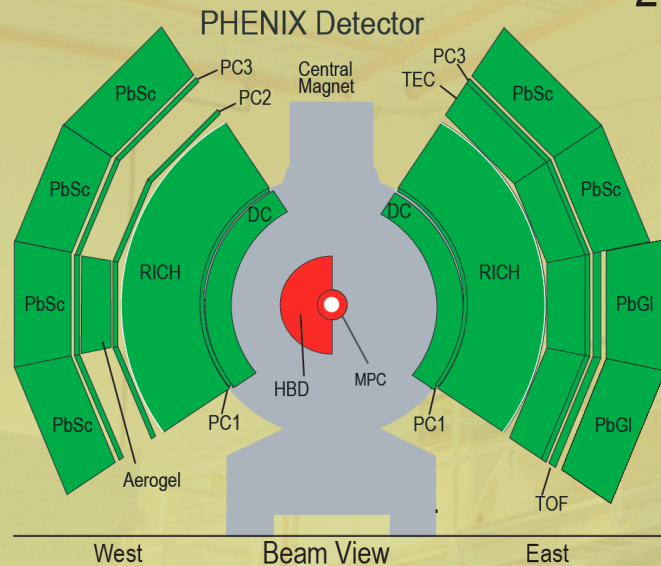
Plot by Phil Pile

100 x 100 Gev pp RUN05-06, PHENIX Integrated Luminosity  
(final delivered)



# PHENIX Detector in 2006

2006



## Central Arm Tracking

Drift Chamber, Pad Chambers

Time Expansion Chamber

$-0.35 < \eta < 0.35$

$\delta\phi \sim 90$  on each side (east & west)

## Calorimetry

PbGl, PbSc

## Particle Id

Muon Identifier: North Muon

Identifier, RICH, TOF

TEC

## Muon Arm Tracking

Muon Tracker: North Muon Tracker

## Global Detectors

BBC

ZDC/SMD Local Polarimeter

Forward Hadron Calorimeters

**Engineering Run for: Muon Piston Calorimeter (MPC) & Prototype Hadron Blind Detector (HBD)**

# The Spin Program at PHENIX

- **Direct measurement of polarized gluon** distribution using multiple probes
  - 200 GeV CM program to end in 2009 with  $\sim 275$  pb $^{-1}$  delivered
  - 500 GeV CM program to start in 2009
  - Low  $x$  exploration of  $\Delta G$  will need the VTX tracker upgrade (DOE)
- **Direct measurement of anti-quark polarization** using parity violating production of  $W^{+/-}$ 
  - Of interest beyond 2009 but preparations need to begin now
  - The Forward Muon trigger upgrade funded on its way (NSF,JSPS)
- **Transverse Spin:** Transversity and transverse spin effects: possible connections to orbital angular momentum?
  - Approximately 25% of total operations of RHIC spin would be in transverse mode

# PHENIX Run-6 Planning

From Run-3+4 to Run-5 we had achieved an improved figure of merit ( $P^4L$ ) of  $\sim 25$  for the longitudinal asymmetry physics ( $\Delta G$ ) program. Based on YOUR projections another such factor seemed unlikely, and the cold snake had only given us 50% polarization

*What qualitatively new physics could PHENIX pursue in a short pp run?*

**Transverse physics with back-to-back pion correlations**

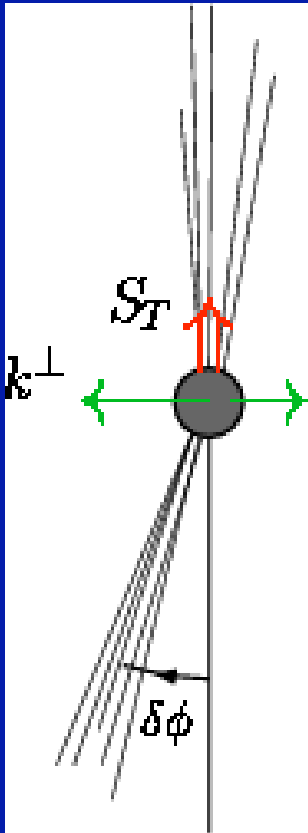
**A short 62.4 GeV pp run for comparison with HI data**

**Machine studies for 500 GeV program**

**Proposed and supported a (1 day test + 2 day operations) of  
22 GeV CM Collisions**

**If remaining time was not enough for a change of species accumulate  
luminosity and polarization towards the  $\Delta G$  program**

# Exploratory Sivers Function Measurement



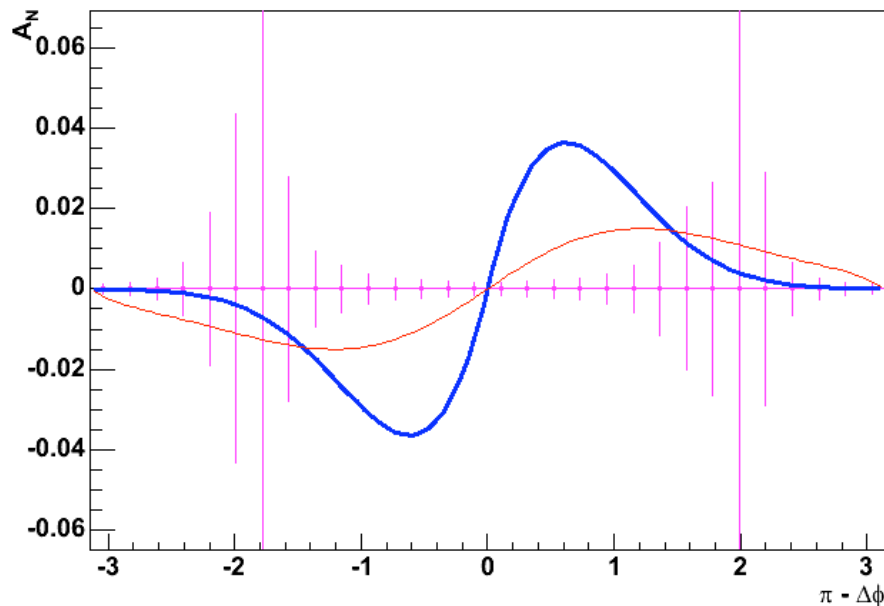
- **Boer and Vogelsang, *Phy. Rev. D*69, 094025, 2004; hep-ph/0312320**

$$\hat{f}(x, k_T, S_T) = f(x, k_T) + \frac{1}{2} \Delta^N f(x, k_T) \frac{S_T \cdot (P \times k_T)}{|S_T| |P| |k_T|}$$

- Sivers distribution is a transverse parton momentum distribution correlated with nucleon's spin axis, which could arise from orbital angular momentum
- A non zero Sivers function means that there will be a left/right asymmetry in the  $k_T$  of the partons in the nucleon
- This asymmetry will lead to an asymmetry in  $\delta\phi$  distribution of back to back jets
  - Statistically more jets on the left vs. right for positive Sivers function
  - Should also be able to see this with fragments of jets (hadrons)

# Phenix Sensitivity to Sivers Function

di-hadron back-to-back  $A_N$



- Blue Curve: Fig.3 from hep-ph/0312320
- Red Curve: Blue curve after accounting for di-hadron smearing (fragmentation) and realistic polarization
- Error bars: Expected sensitivity with  $\sim 50\%$  beam polarization and  $\sim 4-7 \text{ pb}^{-1}$

- Sivers function measurement in PHENIX from Run-6 will be one of the early exploratory measurements of non-zero transverse spin effects which **could be connected** to the existence of orbital angular momentum
- If found significant, could also explain the low(???) value of polarized gluon distribution, apparent from the recent  $\Delta G$  searches at RHIC and other experiments

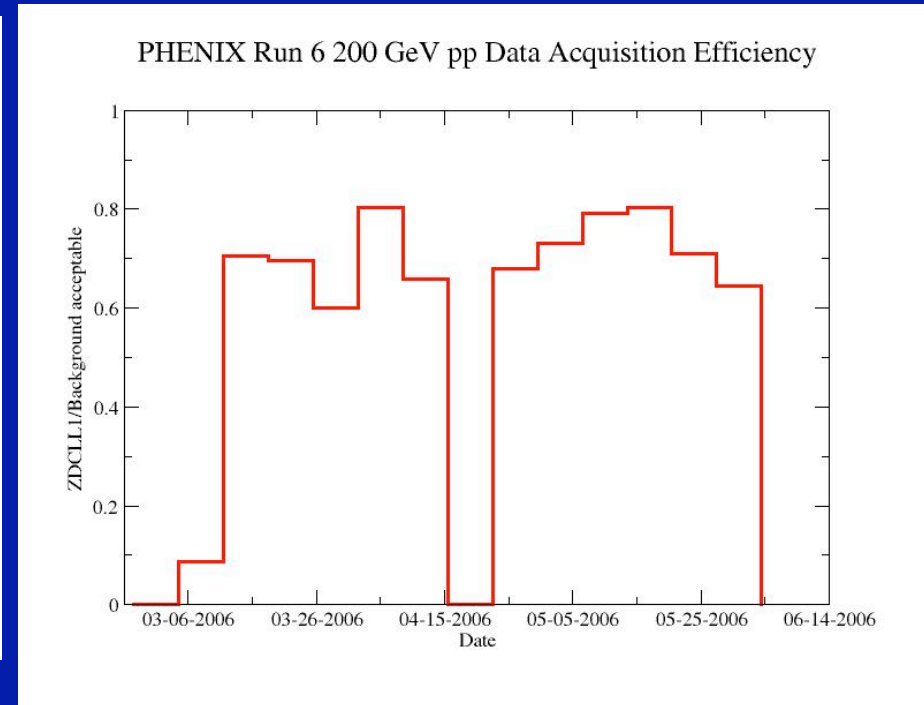
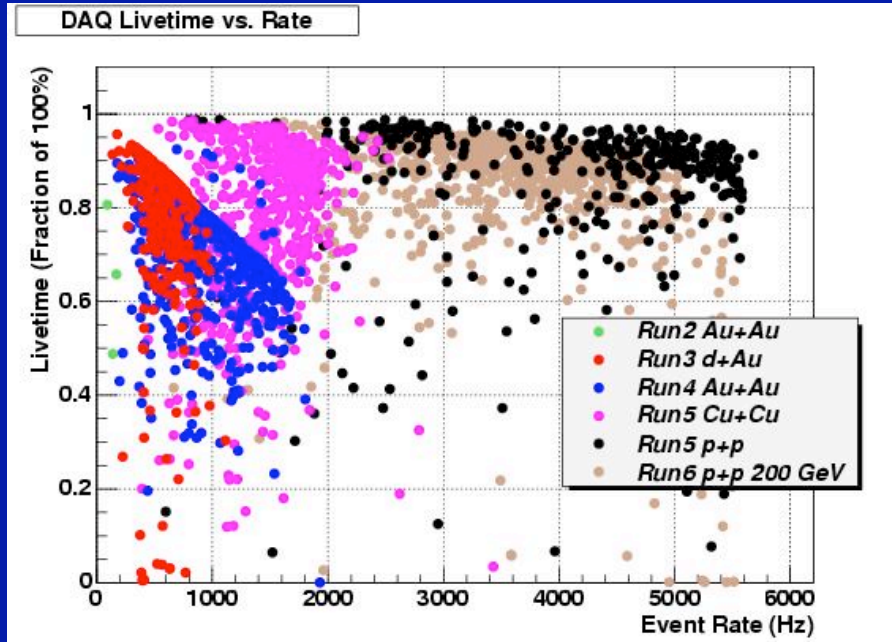


# PHENIX Operations & Run-6 data

# PHENIX Operation

- **Run Coordinator (for the run) + Operations Manager**
- **Supported by a Superb technical support teams from CA and 1008**
- **2-week long duties of Period Coordinators**
- **Weekly shifts: Shift Leader and DAQ Operator**
  - Supported by 3 more people supporting: Detector monitoring, Online Detector Response monitoring and Data handling
- Watch Shifts with SL and 2 support personnel began February 5, 2006
- **Detector Specialists Shifts** of 2 weeks at a time **on call**
- Full shift operations began February 20, 2006
- CAD declared physics March 5, 2006
- PHENIX declared physics March 8, 2006, although PHENIX was already taking data on March 5 when physics was declared by CA.
- **>300 of the PHENIX collaborators were at PHENIX this run one time or the other!**
  - *As evidenced by sometimes having a difficulty in getting a parking spot near the PHENIX counting house*

# PHENIX Run-6 Operations.....

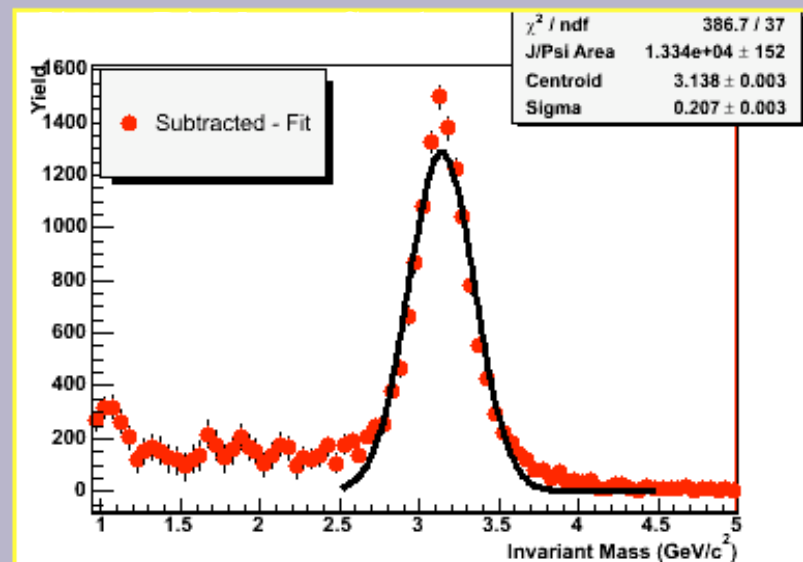
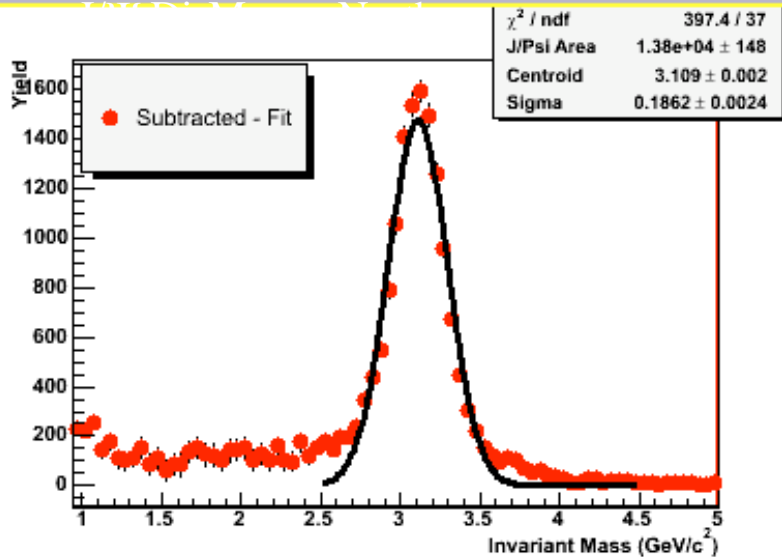
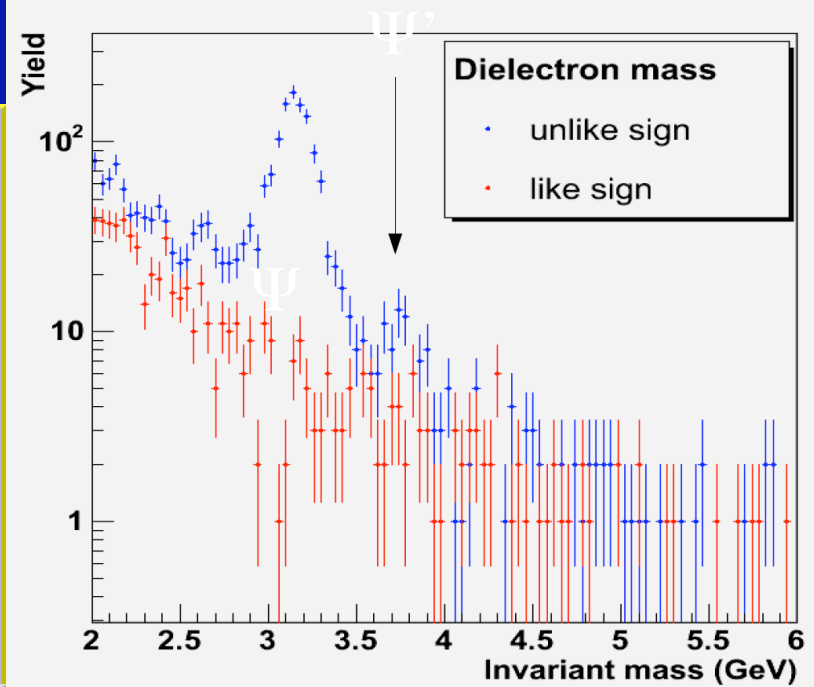
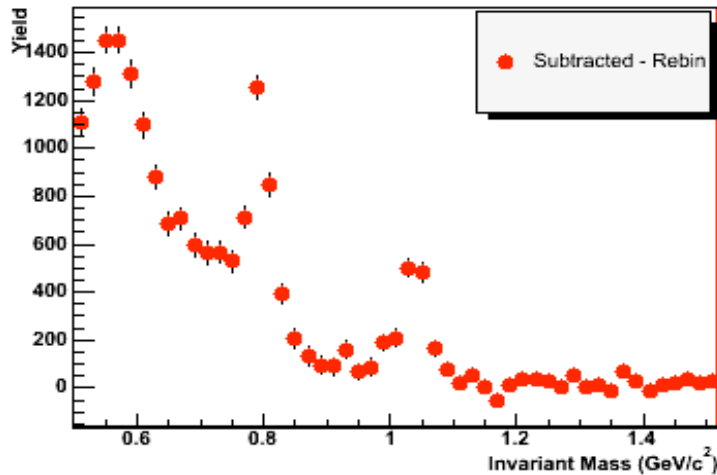


Routine operations with DAQ live fractions times  $> 80\text{-}90\%$   
at DAQ rates of  $(2.0\text{-}5.5)$  kHz

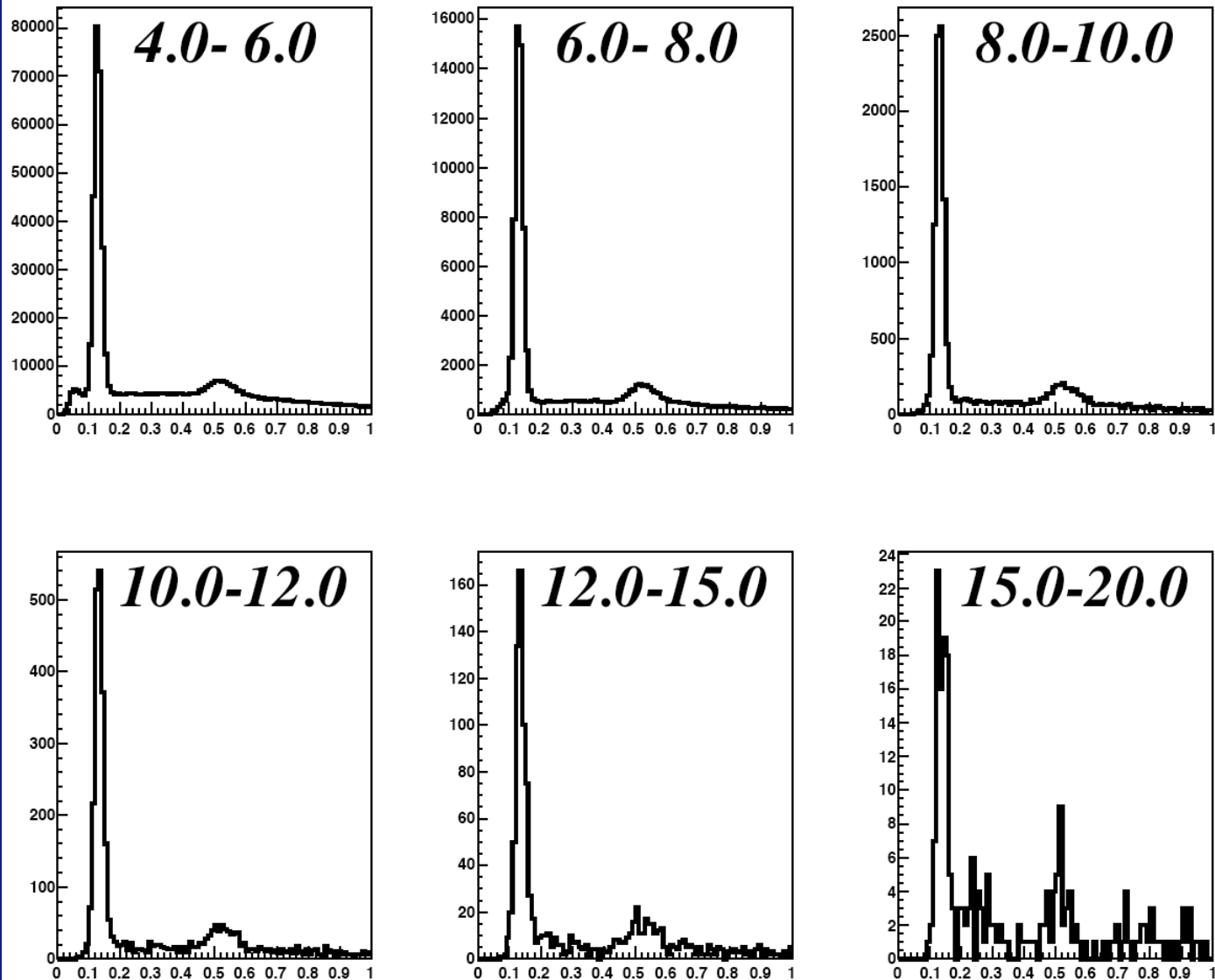
DAQ operational  $70\text{-}80\%$  (when backgrounds acceptable)

Overall PHENIX DAQ experience was much more enjoyable  
than the first few years! (comments by our shift crew)

# Level 2 Filter

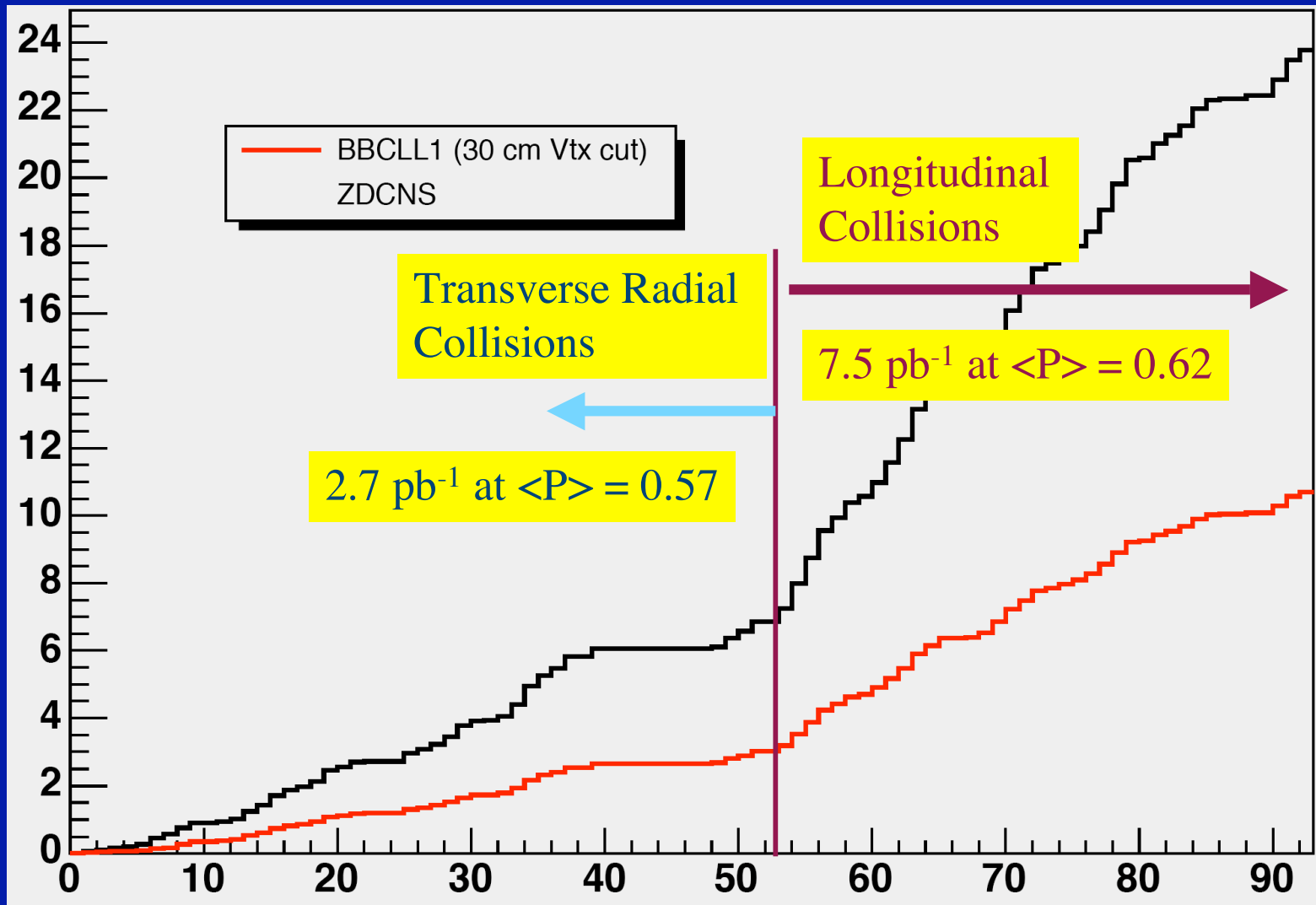


# Level 2 filter: $\pi^0 \rightarrow \gamma\gamma$ , $\eta^0 \rightarrow \gamma\gamma$



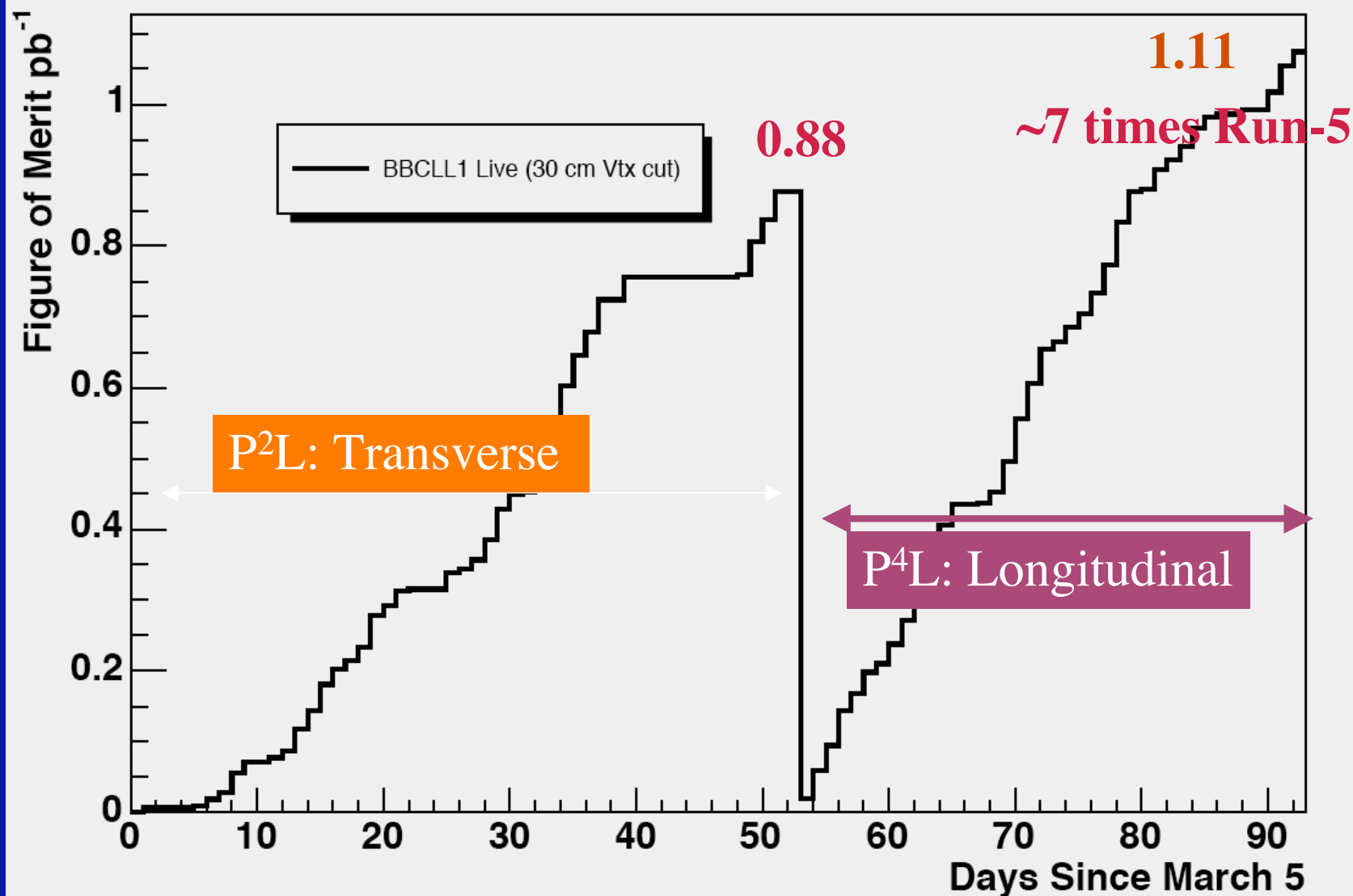
# PHENIX Accumulations at 200 GeV

Luminosity  $\text{pb}^{-1}$



Days since March 5

# Run-6 Data Figure of Merit

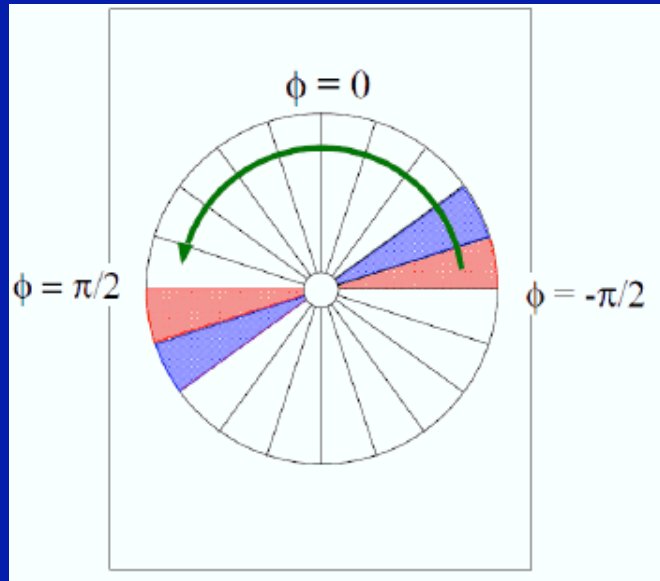


## 62.4 GeV operations

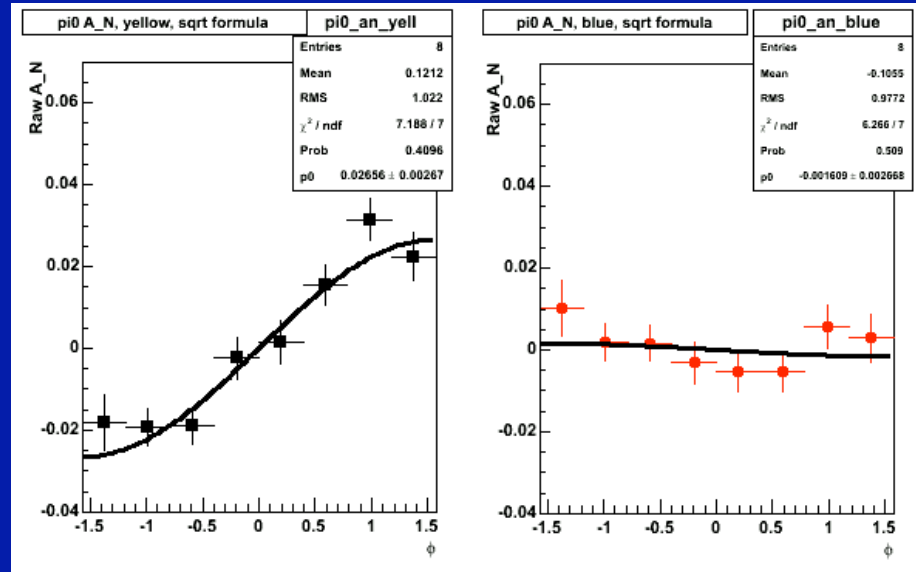
- Principle Aim: To get a comparison data set for HI Au-Au and Cu-Cu data at the same CM energy
  - Any data set around  $100 \text{ nb}^{-1}$  was the goal, and this was reached
  - As a secondary goal, we would have liked to see  $\sim 150 \text{ nb}^{-1}$  longitudinal polarized collisions to measure  $\Delta G$  in a different kinematic region
    - This was not reached, but a good data set with about  $80 \text{ nb}^{-1}$  luminosity is on tape
    - $20 \text{ nb}^{-1}$  with transverse collisions allowed to see first results from the MPC (muon piston calorimeter) almost online
- While the operation was marred by frequent interruptions and while we did not make our spin goal, we believe over all this was a successful run for PHENIX



# MPC Left-Right Transverse Asymmetry

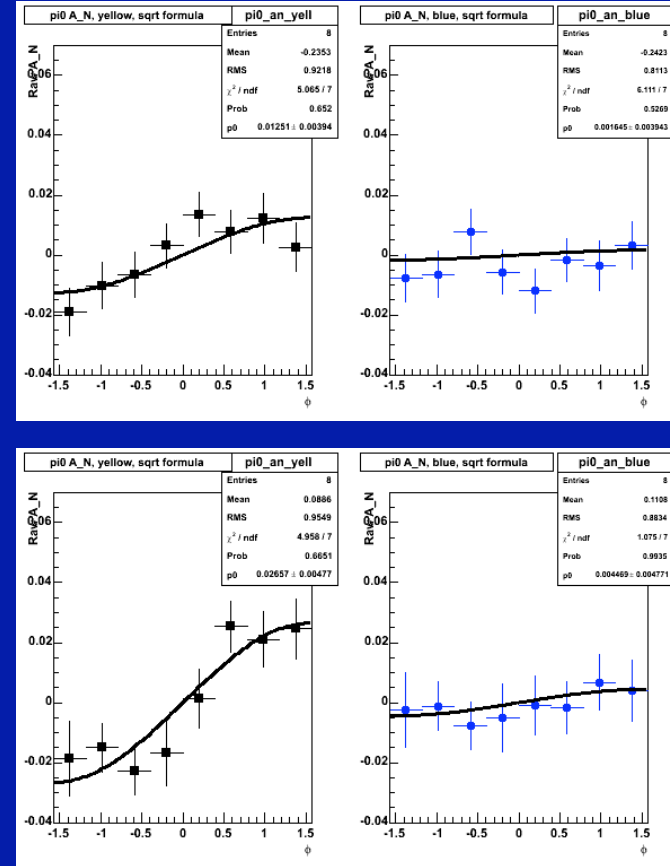
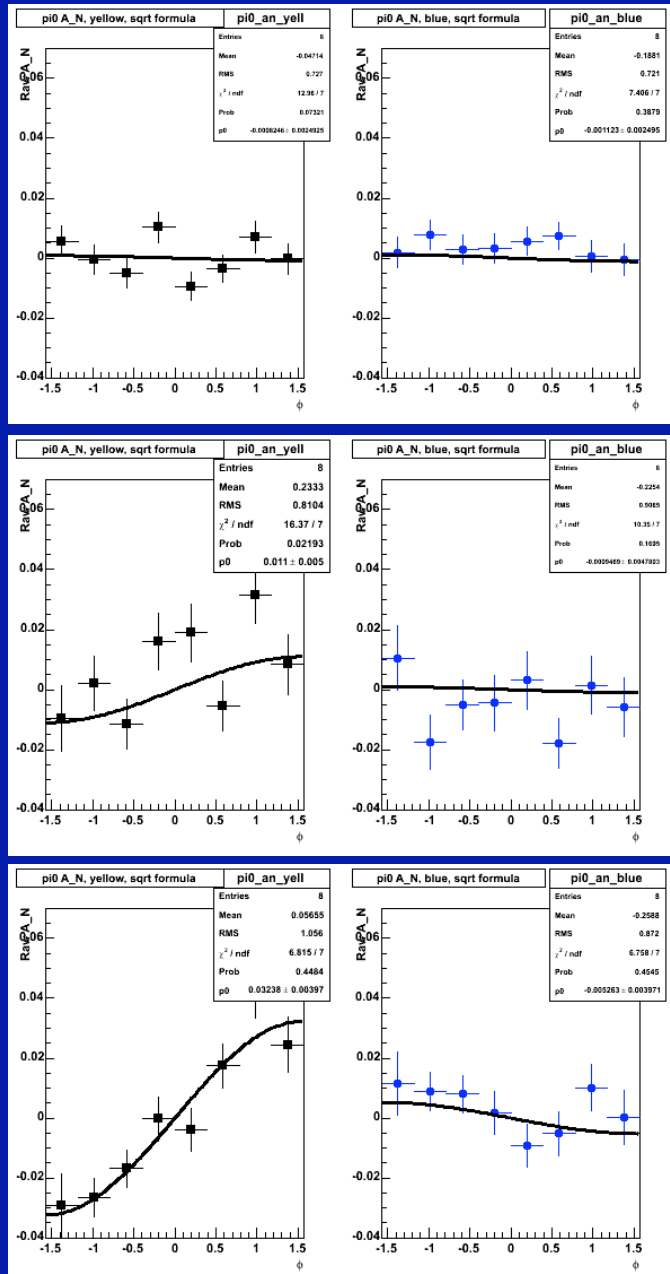


$$A_N \equiv \frac{1}{P} \frac{\sigma_{\uparrow} - \sigma_{\downarrow}}{\sigma_{\uparrow} + \sigma_{\downarrow}} \approx \frac{1}{P} \frac{\sqrt{N_L^{\uparrow} N_R^{\downarrow}} - \sqrt{N_L^{\downarrow} N_R^{\uparrow}}}{\sqrt{N_L^{\uparrow} N_R^{\downarrow}} + \sqrt{N_L^{\downarrow} N_R^{\uparrow}}}$$



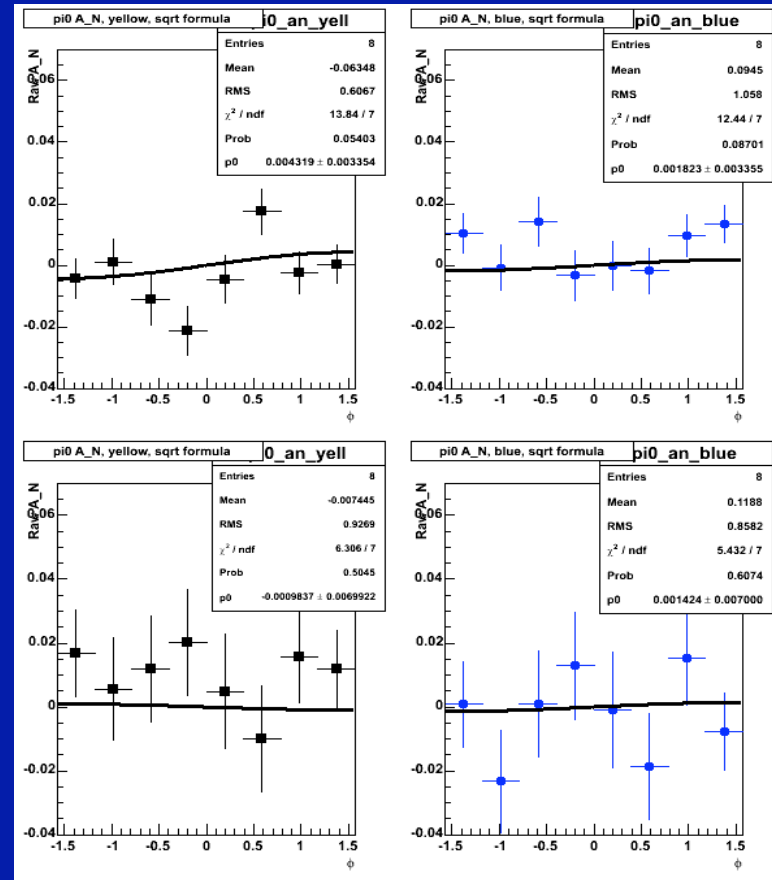
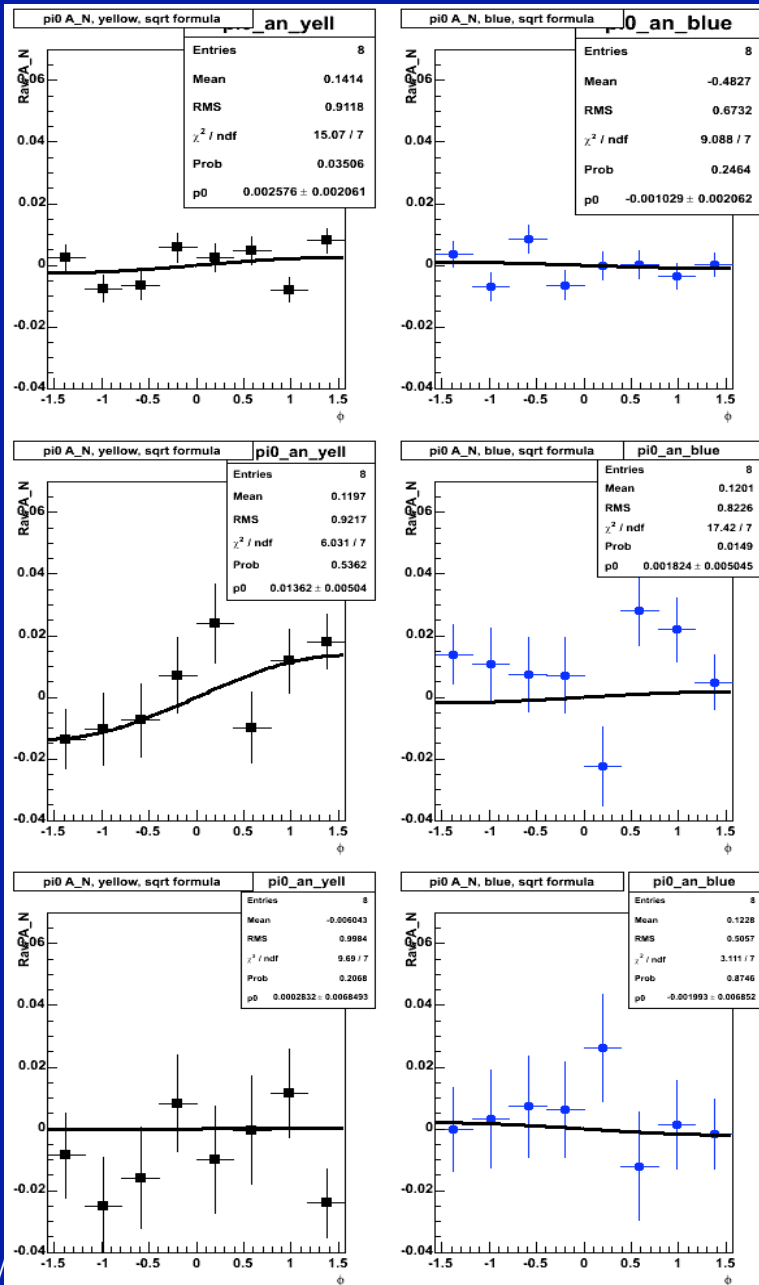
- Asymmetry seen in yellow for high  $x_f$ , not in blue
- Using runs 20596, 20597, 20598 (transverse 62 GeV)
- 3x4 tower sum clustering, no splitting
- cuts: mass > 0.01 && mass , 0.30
- no bkg subtraction, yet

# MPC 62 GeV Transverse Asymmetries



asymmetry only in yellow  
A function of  $x_F$

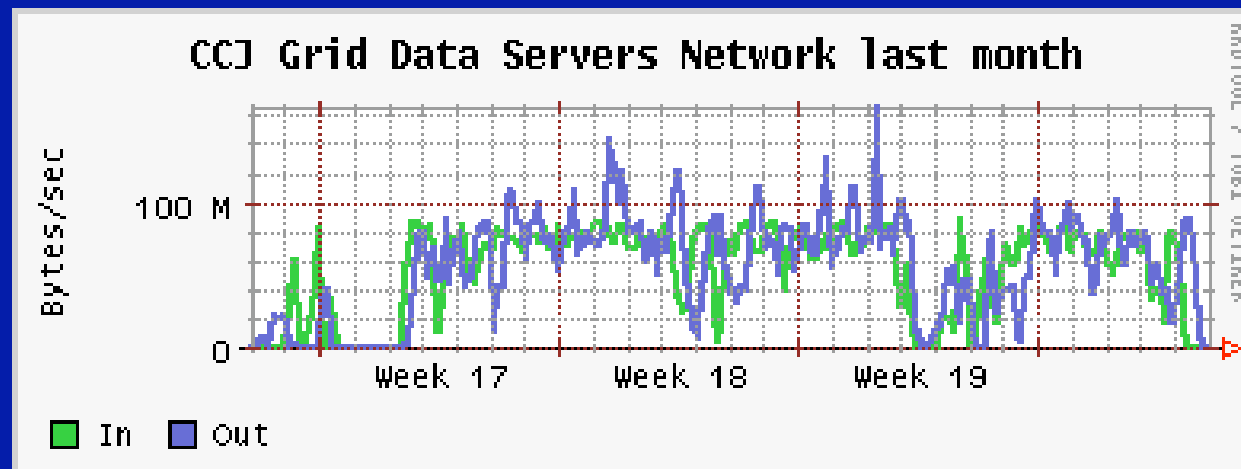
# MPC 62 GeV Long. Asymmetries



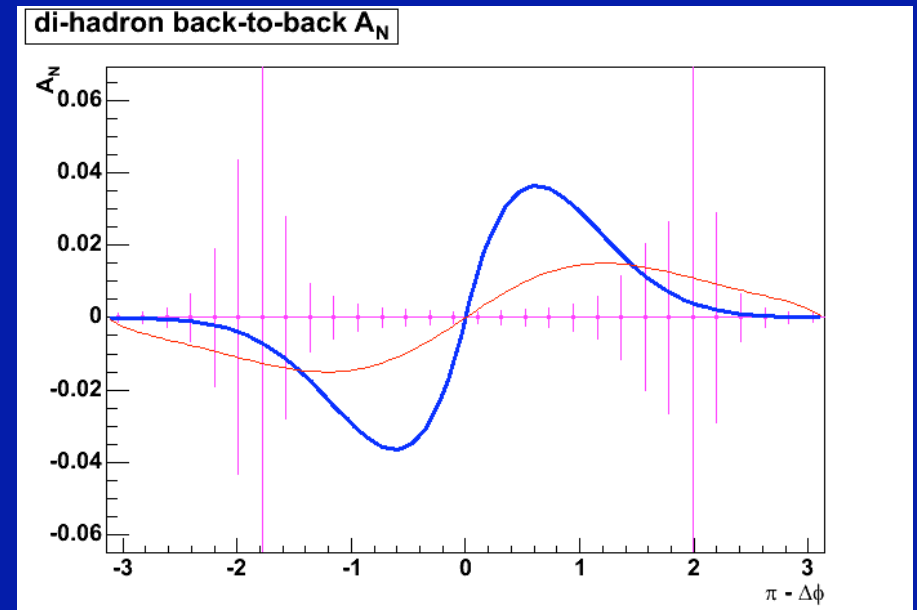
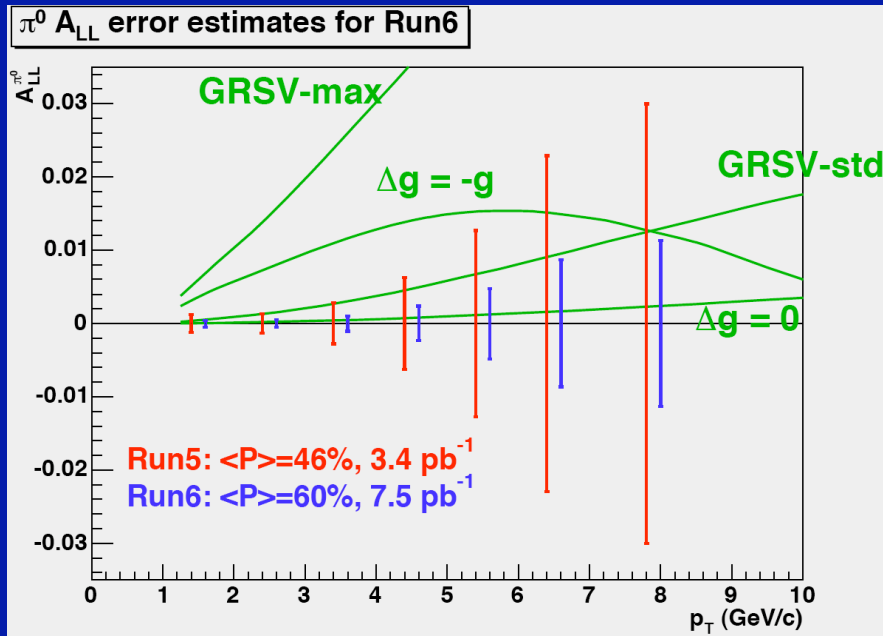
asymmetry disappears!

# Data Production Plans

- *PHENIX Aim: to finish the production of all its data including the Run-6 before the start of Run-7*
- Production of Run-6:
  - RCF (200 GeV CM, transverse radial data set)
  - CCJ/RIKEN (200 GeV CM, longitudinal data set)
  - PHENIX Local farm (62.4 GeV data set)
- Data has been routinely transferred at 80MB/sec to CCJ, and the production will start next month.



# Expected Spin Results from this run....



Others include: (not shown)

- 1) longitudinal double spin asymmetry at 62.4 GeV,
- 2) first spin results both in longitudinal & transverse operations from the muon arms,
- 3) And the HI physics related results from comparison of ongoing 62.4 GeV

# Comments on CA-PHENIX communication (A)

- Daily meetings 8:30 CA meetings
- Scheduling Physicist Extremely efficient and proficient!
  - Weekly meetings: RCs and Scheduling physicist
  - Email & cell phone communication effective
  - *Occasional visits by scheduling physics to PHENIX counting room welcome!*
- Weekly Time and Scheduling meetings (Phil Pile Meetings)
- APEX Machine Experiments schedules: No complaints
- Weekly, bi-weekly, tri-weekly scheduled maintenance
  - Should try to minimize interruptions
  - Weekly to start with, twice a month a little later, and then once in three weeks from mid-run onwards
- Consider longer but fewer scheduled maintenances:
  - Jump from 68 nb-1/day to 250 nb-1/day post STAR event
  - Why was that? Was it the maintenance time windfall of ~7 days?

# A- and below

- MCR to SL communication
  - A lot of this depends on personalities
  - Generally PHENIX SL and MCR communication was very good
  - We had no major issues
  - The experienced PHENIX SLs were missing towards the end and may have caused some concern to us and some to you.
- Polarization measurement:
  - **Even if it is on fixed times, I recommend HIGHLY that MCR should call EXPERIMENTS no matter what.**
    - Repeat measurements always a problem
    - Non-Spin SLs would have a hard time judging the quality of polarization measurement and hence the chance of a repeat measurement
- Vernier scans
  - Were great when AD was in charge
  - We regretfully saw ONLY THOSE VSs to be good.
  - **CA needs to prepare OTHERS to be as good as AD**

# Run-7

- *No PHENIX wide decision yet: **Executive Council will meet on Thursday 7/13 for decision.*** Most WGs have made their inputs available to the collaboration. Various scenarios being discussed with passion!
- Leading proposals being considered:
  - **P-P + Au-Au**
  - Does not mean this will eventually win.... The d-Au issues are also in the play
- ***My Comments/perception:***
  - Need for luminosity and polarization development for pp at 200 and 500 GeV is generally appreciated, but whether it has to be accompanied by collisions for physics is something that is not appreciated by the non-Spin-PWGs. **SPIN group has made a strong case for this**
  - It is thought that being competitive with LHC a Au-Au data set 10 times larger than we have so far, would be necessary. To be acquired in two runs. Runs 7 and 9 or 8 and 9?
  - Difficulties in LHC succeeding in d-Au, has put this on a lower priority



# A possible 5 year scenario....

Run 6	<p>12 wks pp 200 GeV (10/pb)</p> <p>2 wks pp 62.4 GeV</p> <p>22 and 500 GeV development</p>
Run 7	<p>15 wks 200 GeV Au-Au run HBD, RP (1/nb Run4=0.24/nb)</p> <p>10 wks 200 GeV pp (25/pb)</p> <p>? Wks 22, 500 GeV development</p>
Run8	<p>10 wks 200 GeV d-Au with HBD (28/nb, Run3=2.7/nb)</p> <p>10 wks pp 200 GeV</p> <p>5 wks ?? Something else? Species Center of Mass Energy?</p>
Run9	<p>15 wks Au-Au low energy with e-cooling, HBD and VTX upgrade?</p> <p>5 wks pp 200 GeV (with VTX upgrade)</p> <p>5 wks pp 500 GeV (first physics) (commissioning Mu Trigger &amp; VTX)</p>
Run10	<p>13 wks of 200 GeV UU with VTX &amp; Muon Trigger</p> <p>12 wks 500 GeV pp VTX and Mu Trigger complete</p>
Run11	<p>15 wks 200 GeV UU with VTX barrel + EndCap + Nose Cone</p> <p>10 wks 500 GeV pp</p>

# Summary

- Run 6 has been immensely successful
- We have taken our largest set of data at high polarization, and we anticipate significant spin (and other pp) results from this run
- Budgets for Run-7 look optimistic: Beam User Proposals are now being prepared
  - September 15, 2006 PAC meeting
  - August 15, 2006 BUP requested
  - BUP in PHENIX will be discussed on Thursday 7/13 in the Executive Council meeting and recommendations will be made to the Spokesperson.